## REMARKS

This amendment is responsive to the Office Action mailed March 24, 2008. Reconsideration and allowance of **claims 12 and 14-20** are requested.

## The Office Action

**Claims 1, 5, 7-14, and 18-20** were rejected under 35 U.S.C. 103(a) as being unpatentable over Jolly (U.S. Patent Application Publication No. 2003/0069494) and further in view of Melton (U.S. Patent No. 5,195,521).

**Claims 2-4, 5, 15 and 17** were rejected under 35 U.S.C. 103(a) as being unpatentable over Jolly (U.S. Patent Application Publication No. 2003/0069494) and in view of Melton (U.S. Patent No. 5,195,521) and further in view of Avinash et al. (U.S. Patent No. 6,980,682)

**Claim 16** is not rejected on air and is understood to be allowable.

## The Present Application

The present application is directed to a method for calculating total left ventricular volume during a cardiac cycle on cine cardiac imaging, images are generated in about 20 cardiac phases. To determine the LV volume in each phase, each slice of each of the 20 phase images has its endocardial contours segmented. Segmenting is a time consuming undertaking often involving extensive manual labor. The present application eliminates most of the segmenting. Only endocardial contours in the end-diastole (ED) are delineated or segmented. The ED contours are applied to the other cardiac phase images even though they are incorrect (too large). However, the erroneously included tissue shows up dark while the blood is bright. By looking at the intensity of the other phase image slice (e.g. how many bright voxels vs. how many dark voxels) relative to the end-diastole image slice; the present application recognizes that the intensity rates (a simple calculation) can be used to scale the ED volume to the volume in the other phase. In this manner it provides a method being less computational demanding than the prior art methods so that the results are faster.

This synopsis is to facilitate the Examiner's quick understanding of the application and is not to be taken as limiting the application.

## The References of Record

Jolly is directed at a method for segmenting a magnetic resonance image of interest of a left ventricle. It is the complex method of Jolly that the present application eliminates for all but the ED phase image. The Jolly method includes determining a myocardium contour according to a graph cut of candidate endocardium contours, and a spline fitting to candidate epicardium contours in the absence of shape propagation. The method further includes applying a plurality of shape constraints to candidate endocardium contours and candidate epicardium contours to determine the myocardium contour, wherein a template is determined by shape propagation of a plurality of magnetic resonance images in a sequence including the magnetic resonance image of interest in the presence of shape propagation. Thus, Jolly tells how to segment, not how to avoid segmenting.

Melton is directed to an ultrasound system that images based on acoustic reflections by interfaces. The system for deriving signals representing a selected cross sectional area and volume of a region of interest in tissue. The volume is based by detecting the locations along each line that are in fluid, deriving a signal representing the incremental area within fluid that is between adjacent scan lines, deriving a signal representing the cross sectional area of a cavity within a region of interest by summing the incremental areas and deriving a signal representing the volume of the cavity within a region of interest by revolving each incremental area about an axis of the cavity so as to form an incremental volume of revolution and summing the volume of revolution.

Avinash et al. is directed to a method and apparatus is provided for segmenting a left ventricular endocardium in a magnetic resonance image. Image shape, size, gradients, intensity, and connectivity are used to locate the endocardial boundary. Specifically, a series of dilations and refinements to a mask corresponding to acquired data is performed. Variations in intensity, representing the endocardial

boundary, are detected, and the endocardial boundary may then be clearly identified in the MR image.

**The Claims Distinguish Patentably Over the References of Record**

**Claims 1, 5, 7-14, and 18-20** are patentable over Jolly (U.S. Patent Application Publication No. 2003/0069494) in view of Melton (U.S. Patent No. 5,195,521).

More specifically, regarding **claim 1**, Jolly shows how to segment images. Jolly fails to recognize that once the ED volume is determined, the volumes of the other phase images do not need to be segmented.

Jolly does not disclose the claimed method for determining total left ventricular (LV) interior volume during a cardiac cycle from a cardiac cine series. The examiner asserts that Jolly teaches a method of determining total left ventricular (LV) interior volume during a cardiac cycle from a cardiac cine series in paragraphs [0033] and [0058]. Paragraphs [0033] and [0058] of Jolly disclose that Jolly's method for segmenting a magnetic resonance image can be embodied in any suitable commercial cardiac analysis package and can be used specifically with Seimen's MAGNETOM system which uses TrueFISP pulse sequences for cardiac cine imaging. Paragraph [0058] discloses that the use of Jolly's method for segmenting a magnetic resonance image can allow the user the ability to avoid outlining the blurry edges of the images by using their new shape constraint image segmenting method. It is respectfully submitted that Jolly does not teach a method for determining total left ventricular intention volumes during a cardiac cycle from a cardiac cine series as disclosed in claim 1 of the instant application in either paragraph [0033] or in paragraph [0058]. Additionally, it is respectfully submitted that the prior art cited does not provide an enabling disclosure. MPEP 2121 states that "a prior art reference provides an enabling disclosure and thus anticipates a claimed invention if the reference describes the claimed invention in sufficient detail to enable a person of ordinary skill in the art to carry out the claimed invention." Examiner asserts that the method of determining the total left ventricular interior volume is disclosed in paragraph [0033] of Jolly.

Paragraph [0033] of Jolly discloses that cardiac analysis packages allow physicians, using the tools of the packages, to determine volumes. The reference does not itself describe determining the total left ventricular interior volume during a cardiac cycle from a cardiac cine series comprising the steps disclosed in claim 1 in sufficient detail to enable a person of ordinary skill in the art to carry out the method.

Additionally, **claim 1** has been amended to disclose the method of determining left ventricular (LV) interior volume during a phase of the cardiac cycle from a cardiac cine series comprising the steps of calculating intensity within the endocardial phase delimitation and calculating intensity in another phase using the ED phase delineation. The volume in the another phase is determined from these intensities and the ED volume. The examiner asserts that Jolly teaches calculating LV interior volume, evaluating the total number of slices, calculating the volume of the LV at end diastole, and detecting intensity of the slice within the endocardial delimitation in paragraphs [0011], [0033], [0034], [0040], and [0049]. Paragraph [0011] discloses determining the myocardium response image according to the histogram of pixel intensity further using Gaussians to determine portions of blood, muscle, and air in the image. Paragraph [0033] of Jolly discloses that cardiac analysis packages allow physicians, using the tools of the packages, to determine volumes. Paragraph [0034] discloses the method to determine approximate contours of the left ventricle and using shape information and a matching technique to determine a myocardium image. Paragraph [0040] discloses that the ED contours can be propagated to all the slices in order for a more detail analysis. Paragraph [0049] discloses that different energy functions highlight different features of the myocardium. It is respectfully submitted that Jolly does not teach determining the LV interior volume based on intensities and the ED phase volume. Although Jolly teaches using pixel intensities to determine the approximate contours of the left ventricle and produce a myocardium response image it does not disclose using relative intensities and the ED volume.

**Claim 4** has been placed in independent form incorporating the subject matter from **claim 1**.

In regards to **claim 4**, the examiner asserts that Jolly teaches calculating the total LV interior volume based on intensity values for each of the phases inside the endocardial contours delineated at the ED and applied to all the phases in

paragraphs [0002]-[0004], [0007], [0033], [0042], and [0059]. Paragraphs [0002]-[0004] teach the problem of cardiovascular disease and what medical areas physicians are interested in to help diagnose cardiovascular disease. Paragraph [0059] discloses the error analysis of using the Jolly method for segmenting of the left ventricle and the error seen when comparing the automatically segmented contours to the true contours of the left ventricle. Paragraph [0007] teaches the method for segmenting a magnetic resonance image which includes determining a myocardium contour as well as applying a plurality of shapes constraints to candidate endocardium contours and candidate epicardium contours to determine myocardium contour. Paragraph [0033] teaches that Jolly's method for segmenting a magnetic resonance image can be embodied in any suitable commercial cardiac analysis package. Paragraph [0042] teaches the method to create a myocardium response image using intensity of pixels and an Expectation Maximization method. It is respectfully submitted that Jolly does not teach calculating the total LV interior volume based on intensity values for each of the phases as disclosed in claim 4 of the instant application in paragraphs [0002]-[0004], [0007], [0033], [0042], and [0059].

Additionally with regards to **claim 4**, the Office Action states that Jolly does not disclose calculating a total ED intensity value and asserts that Melton discloses the subject matter. It is respectfully submitted that the combination of Jolly and Melton do not establish a prima facia case of obviousness. Jolly being an MR technique and Melton an ultrasound technique, their resultant images have very different characteristics. There is no apparent or explained reason for combing those two different techniques. The combination of references does not teach or suggest all the claim limitations. Melton does not disclose or even suggest, even in combination with Jolly, calculating a total ED intensity value inside at least one of the endocardial contours at the ED. The examiner refers the applicant to the abstract and col. 8 lines 19-41 of Melton. The abstract and col. 8 lines 19-41 disclose a method for determining a volume of a region by scanning between a plurality of scan lines, deriving a signal representing the cross sectional area of a cavity within a region of interest, and deriving a volume of the cavity within a region of interest by revolving and summing the volume of revolution. It is respectfully submitted that Melton does not disclose calculating a total ED intensity value. Additionally, Examiner asserts that

it would have been obvious to one of ordinary skill in the art to modify the Gaussian values as taught by Jolly to be represented as a total intensity value as taught by Melton in order to provide an alternative method of calculating ventricle volume. It is respectfully submitted that Jolly and Melton combined do not teach the alternative method of calculating ventricle volume. Jolly and Melton do not teach using the total intensity as well as a detected intensity to find a first fraction intensity value which is then multiplied by a calculated volume to find a total LV interior volume.

Additionally with regards to **claim 4**, the Office Action asserts that Jolly does not teach the equation verbatim but teaches calculating LV interior volume, evaluating the total number of slices, calculating the volume of the LV at end diastole, and detecting intensity of the slice within the endocardial delimitation in paragraphs [0011], [0033], [0034], [0040], and [0049]. Paragraph [0011] discloses determining the myocardium response image according to the histogram of pixel intensity further using Gaussians to determine portions of blood, muscle, and air in the image. Paragraph [0033] of Jolly discloses that cardiac analysis packages allow physicians, using the tools of the packages, to determine volumes. Paragraph [0034] discloses the method to determine approximate contours of the left ventricle and using shape information and a matching technique to determine a myocardium image. Paragraph [0040] discloses that the ED contours can be propagated to all the slices of the same phase image in order for a more detail analysis. Paragraph [0049] discloses that different energy functions highlight different features of the myocardium. It is respectfully submitted that Jolly does not teach finding the total LV interior volume by dividing a first slice intensity value by the total ED intensity in order to find an intensity factor which is then multiplied with a calculated volume of the first ED slice and then summing the slice volumes to form the total LV interior volume.

Accordingly, it is submitted that independent **claim 4** and **claims 2 and 3,** dependent therefrom distinguish patentably and unobviously over the references of record.

Accordingly, it is submitted that independent **claims 17 and 18** are allowable due to their dependence on allowable **claim 16**.

**Claim 20** calls for the method wherein the comprising acts include manually delineating an endocardial contour on an image of a slice, calculating an

image volume based on a signal intensity due to blood contained in the image, forching the image volume to coincide with the manual contour using a calculated factor, and applying the calculated factor to intensity sums of further images of the slices. The examiner refers applicant to paragraphs [0023], [0033], [0058], and [0059] of Jolly for the teaching of this method. Paragraph [0023] discloses the method for segmenting a magnetic resonance image of interest of the left ventricle can be a program storage device embodying a program of instructions to perform the steps of the method. Paragraph [0033] of Jolly discloses that Jolly's method for segmenting a magnetic resonance image can be embodied in any suitable commercial cardiac analysis package. Paragraphs [0058] and [0059] disclose the error analysis of using the Jolly method for segmenting of the left ventricle and the error seen when comparing the automatically segmented contours to the true contours which are found by manually delineating the contour. It is respectfully submitted that Jolly does not disclose forcing the image volume to coincide with the manual contour using a calculated factor and then using that factor to then calculate the intensity sums to further images of the slice as disclosed in claim 20 of the instant application.

## CONCLUSION

For the reasons set forth above, it is submitted that all claims are not anticipated by and distinguish patentably and unobviously over the references of record. An early allowance of all claims is requested.

Respectfully submitted,

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